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Extrusioneering News

Chicagoland's Oldest, Most Experienced Aluminum Extruder

PUBLISHED BY PRECISION EXTRUSIONS INC. BENSENVILLE, ILLINOIS

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Custom aluminum extruded HEAT SINKS

TERMINOLOGY

A	Area, ft.^{2}
a	Dimension, ft.
l	Dimension, ft.
h_c	Convection coefficient, B/hr ft^{2}f
t	Temperature difference, °F
t_b	Base temperature of fin, °F
t_{air}	Ambient air temperature, °F
S	Surface area of fin, ft.^{2}
k	Thermal conductivity, B/hr ft. F
v	Fin efficiency
q	Heat flow rate, B/hr

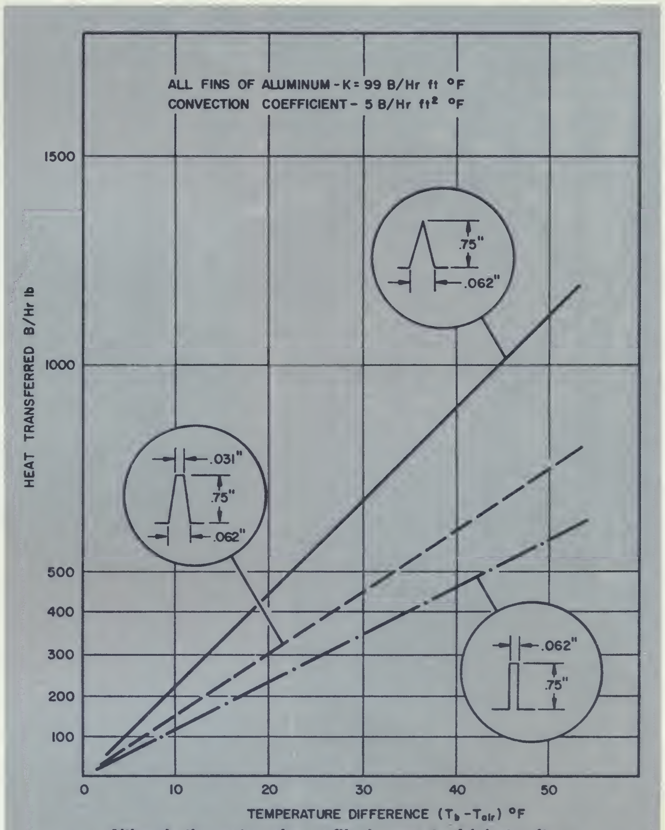
PRECISION EXTRUSIONS, INC.
700 E. Green Ave., Bensenville, Illinois

custom aluminum extruded HEAT SINKS

There are literally hundreds of stock heat sink configurations. Miniaturization demands, however, increase the need for custom components to meet modern packaging requirements.

Precision Extrusions, Inc. has produced a great number of heat sink variations to precise custom specifications. Since Thermodynamics, however, is practically a life study in itself, the combination heat sink designer/manufacturer is few. Precision excels in one facet of this combination! Close tolerance aluminum extrusions, in addition to heat sinks, include components for atomic reactors and other highly technical applications for some of the leading Giants in the Industry!

Since the heat sink is an important component in modern packaging—and not merely an occasional supplement — it should be designed "in" and not around. In doing so, however, there are many factors to consider when designing your heat sink. The closer it is engineered to master specific factors . . . the greater the overall efficiency. For the prototype and the small user, stock heat sinks will serve their purpose. For the precise, O. E. M. user —Precision Extrusions will serve you well.



Although the rectangular profile is easy to fabricate, its operation is relatively inefficient. Compared to triangular and trapezoidal shapes, the figure of merit for a rectangular profile is lowest.

Heat Sink Design

Although stock heat sinks have a place in industry, their cooling efficiency is governed by conditions. Little consideration can be given to fin design, size of fin, spacing flow rate and mounting. All these have to be accepted on a broad plane of general usage. Even when cost is a factor, custom heat sinks can, at times constitute long range savings in better product performance.

Often times fins are not needed in heat sink applications. A flat plate may suffice. Where flat plates serve the purpose, there is no gain in use of fins since bulk of temperature drop occurs near the heat source. When fins are used, their base temperature decreases with the distance away from the heat source. This should be considered when analyzing heat sink requirements.

Which is the best design?

Fin spacing, very important to the design is often ignored; too close can cause "blanking out" . . . and too far, poor operation. Minimum fin spacing should be 1.2 to 2 times the boundary layer thickness. Fins 4" long and used in free convection with free air should be ½" high.

Despite the theoretical advantages of the parabolic fin configurations, economic considerations usually require use of rectangular, trapezoidal, or triangular profiles.

Fins

based on mathematical computations, the fin should transfer heat per pound versus the developed temperature difference. The profiles are extremely important. Tests prove one design superior to the other, however, production difficulties, in many cases, govern the selection.

Fin shape

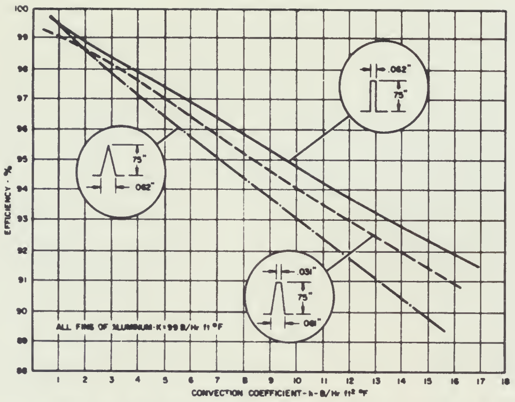
Fin shapes are available in many configurations in stock sinks. Some are made in a certain shape because of ease of production, others for claimed greater efficiency. According to laboratory tests, it has been learned that the most effective, and generally hardest to produce, is the parabolic convex fin, using a popular fin design, the trapazoidal.

Material used

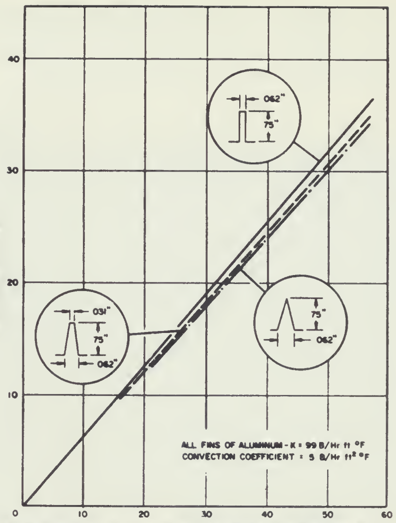
Aluminum is not the only material for heat sink efficiency . . . however, the ratio of weight to conductivity is not always favorable when size and weight are a factor. Copper over aluminum results in a 0.1 B/hr ft improvement of 1½% efficiency, but fabrication and weight costs overshadow any slight advantage. Stamping and forming of other conductive material is also used, but this does not overcome some objectionable factors of weight and size often encountered. Economy and productive speed are other advantages aluminum extruded heat sinks provide. Note in table of characteristics.

Conductivity-Density Ratio for Various Materials

Material	Conductivity, (B/hr ft F)	Density, lb/in.	Conductivity Density
Magnesium, ZE10A-H24	77.0	0.068	1220.0
Yellow brass	67.0	0.306	219.0
Copper, oxygen-free	226.0	0.328	700.0
Aluminum, 6061	99.0	0.098	1010.0
Stainless steel, AISI 302	9.4	0.29	32.4
Stainless steel, AISI 416	14.4	0.29	49.7



Using fin efficiency as the basis for selection reveals that the rectangular configuration ranks above both triangular and trapezoidal fin profiles.



The rectangular fin profile dissipates more heat at a given temperature difference than either trapezoidal or triangular configurations.

Mounting method

Is an extremely important factor to consider in the use, design and success of heat sink applications. Since electricity can be converted from one form to another . . . such as heat, none is lost along the way. It is not really dissipated, as most people think. This is considered in engineering terms as a process in which heat appears as an end result of electrical energy conversion. It is either stored or transferred. A spontaneous energy such as conduction or radiation occurs only in the direction of low temperature. Therefore a hot object placed against a cold object will permit or accept the transfer of heat to itself until both reach the same temperature. Therefore, mounting, being of this same law, can be important not only to the performance of a heat sink, but also to the design. The use of spacers, insulators and mounting lugs could vary heat sink performance.

Shall the heat sink fins touch the chassis? Shall the mounting feet—or brackets—be insulated or shall they be a conductor of the heat through the sink to the chassis? These, all important, questions cannot be answered by anyone other than the design engineer who is going to "custom design" his heat sink into a given component package.

Ratings

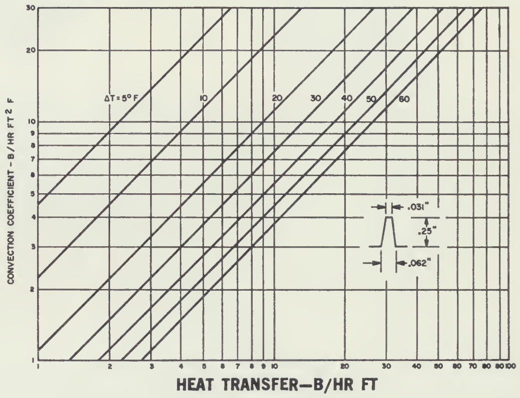
Manufactured heat sink ratings are generally specified in free air suspension. In actual application, however, the heat sink, mounted to a chassis where other components and environmental conditions of majority use must be considered . . . completely change the optimum of performance. From one evaluation to another, characteristics could vary as much as 30%. In the case of a power transistor therefore a hot object placed against a cold one, will permit the transfer of heat one to another. The sink design should have the smallest workable temperature gradient and have the smallest possible physical dimension. Of stock designs tested, in conjunction with manufacturer's ratings, it has been found that under application, ratings varied as much as 100% and as low as 2.76%. This—all important factor—could be the difference between a successful heat sink and a failure . . . the wrong rated unit for the job!

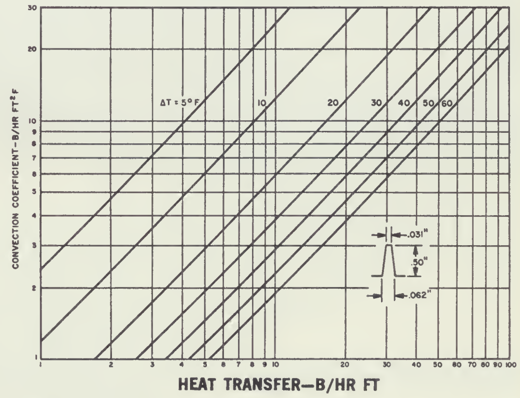
Coefficient for Free Convection for Various Configurations

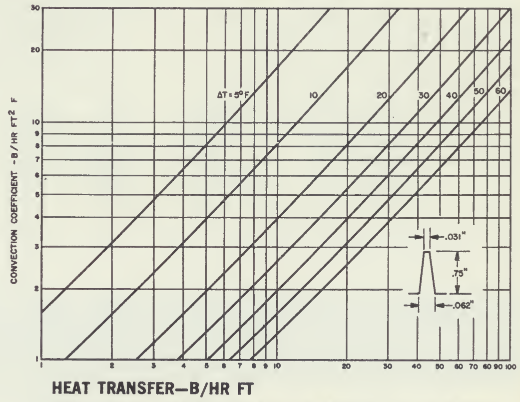
Configuration	Convection Coefficient*
Heated horiz. plate—facing up	0.7 to 1.5 B/hr ft²F
Heated horiz. plate—facing down	0.4 to 0.8 B/hr ft²F
Heated vert. plate—length 1 ft.	0.6 to 1.0 B/hr ft²F

*For a range of temperatures usually found in electronic equipment operating in air.

Consult Precision for your custom heat sink requirements.





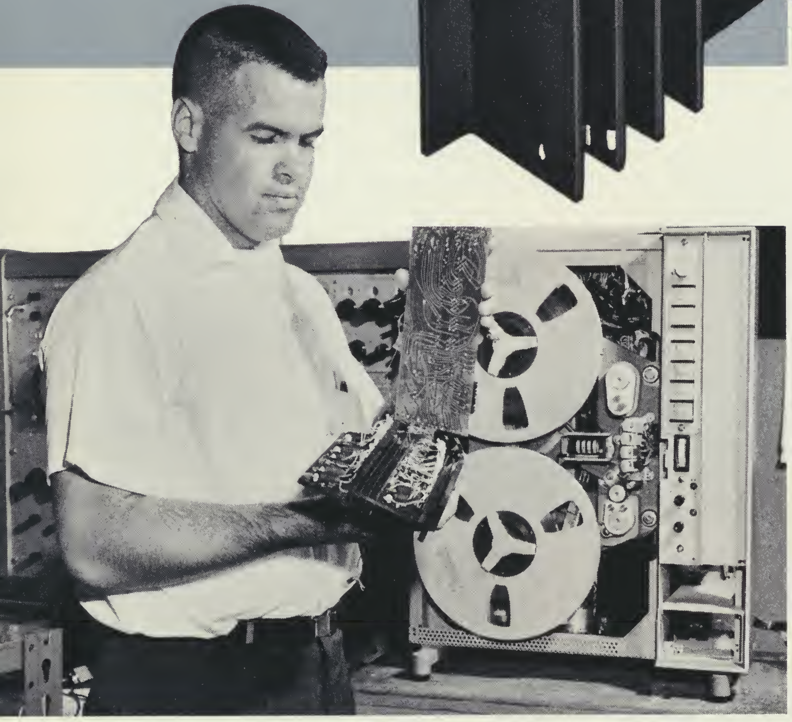


Heat transfer characteristics of trapezoidal fins of various heights: (a) 0.25 in (top); (b) 0.50 m (center); (c) 0.75 in (bottom).

Acknowledgement and appreciation is extended to James L. Saiers, General Precision, Inc. Glendale, Calif. and to Publisher of Electronic Packaging and Production magazine.

The heat sink shown is also for Modine. Units on the cover, are examples of a few of the many custom heat sinks produced by Precision. These have been designed and engineered by and for use in electronics, computors and the atomic developments by the leaders in the field.

Aluminum heat exchangers for miniature electronic components are now being marketed by Modine Manfufacturing Co. The exchangers shown here are cooling black, button-like and operationally hot semiconductors, and illustrate different solutions to the basic problem of dissipating great heat in little space. The aluminum extrusions at lower left has been produced by Precision Extrusions, Inc.; typically used in such modern devices as military radar control systems.



HONEYWELL
The custom designed aluminum extrusion serves multi-purpose use in new Honeywell 8100 portable recorder. The mounting of all transistors and resistors on one unit provides compact cooling efficiency, less weight and ease of installation and service.

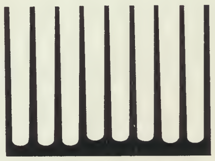
Application Problems?

Precision engineering personnel are ready to help—merely send a sketch of your requirements and you will receive a prompt reply.

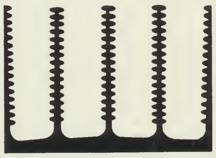
Basic Extrusions

Precision has over 5,000 standard dies for all kinds of applications. Use of basic dies reduces costs guarantees proven results.

QUIPS and TIPS



Efficiency in heat sink design starts on the drawing board. The example above could create many problems in both function as well as in production. The fins are too close for peak performance and they are practically impossible to produce properly.



Note simplification of design permits greater rate of heat flow with even greater perimeter by the use of serrations on the fins. Every other fin has been eliminated plus a very slight increase in the base dimension. Precise efficiency factor of any heat sink is greatly dependent on the method of cooling desired and on the mounting method plus the environmental conditions of the application.

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